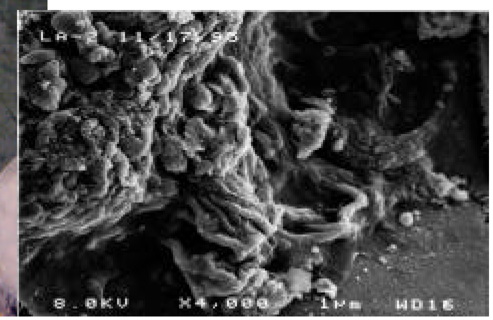
INEEL Biotechnologies Department

Biodecontamination: A technology for biologically removing radionuclide contaminated concrete surfaces

British Nuclear Fuels plc.(BNFL) and the Idaho National Engineering and Environmental Lab (INEEL) are working jointly under a Cooperative Research and Development Agreement to develop a technology that utilizes a naturally occurring phenomenon, microbial degradation of concrete, for removing surface material of radionuclide contaminated concrete. The technology can be described in three stages: application of microbes and nutrients; maintenance of microbial activity; and removal and packaging of surface material for waste disposal. The process is a passive one that essentially leaves the bacteria to actively degrade the cement matrix until the concrete surface material is loosened for easy removal to a desired depth. It is expected that the process will require 6-18 months for completion, depending on the depth and extent of contamination.

Current Research

Laboratory and proof of principal demonstrations have been conducted and optimum conditions for maximum rate of material removal have been established. In controlled experiments, initiation and maintenance of MID bacterial communities on concrete surfaces was induced. Biofilm formation, bacterial production of sulfuric acid, and formation of calcium oxide dissolution products was demonstrated. In proof of concept demonstrations, concrete reactivity with biogenic acid was demonstrated to be as high as 20 times more efficient than mineral acid dissolution alone can account for.



Prototype applications on both vertical and horizontal surfaces, verified that microbial degradation can be initiated and managed over a large surface area of contaminated concrete and also demonstrated that the microbial process can be used to promote the removal of 2-4 mm of contaminated concrete surface. Research to date demonstrates that biodecontamination results in significant waste volume reduction compared to traditional decontamination technologies. Production of secondary and mixed wastes is greatly reduced compared to chemical decontamination methods and occurrence of airborne

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contamination is eliminated. Estimated cost for the process ranges from 0.3 to 5.0% of costs for traditional physical decontamination methods.

Current efforts are focused on optimizing and engineering the application system to provide bacteria and nutrients to the concrete surface in a more cost and time efficient manner. The application process will promote continued bacterial activity for the duration necessary to remove the desired depth of contaminated concrete material with minimal inputs to the system. The preferred method of application involves mixing the bacteria, nutrients, and reduced sulfur source in an inert matrix that is easily sprayed on the surface, is hydrophilic, and adheres to uncoated concrete. Additionally, efforts are underway to adapt and use currently available technology for removal of the concrete debris once the bacteria have loosened the surface. Design of a complete integrated system is expected to be ready for full scale, active demonstration in 1999.

Selected Recent Publications:

Rogers, R. D., M. A. Hamilton, L. O. Nelson and M. Green. 1997. “Microbially Influenced Degradation: A New Innovative Technology for the Decontamination of Radioactively Contaminated Concrete. Proceedings. American Nuclear Society Meeting September, 1997.

Johnson, L. J., R. Rogers, M. Hamilton and L. Nelson. 1997. “Biodecontamination of Concrete Surfaces: Occupational & Environmental Benefits. Proceedings of WM97: HLW, LLW, Mixed Wastes and Environmental Restoration - Working Towards a Cleaner Environment. March, 1997.

Rogers, R. D., M. A. Hamilton, L. O. Nelson, J. Benson and M. Green. 1996. “Evaluation of Microbially Influenced Degradation as a Method for the Decontamination of Radioactively Contaminated Concrete”. In: Gray and Treay (eds.) Vol. 465, MRS Symposium Proceedings, December, 1996.

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